

subjected to mass separation in said Q-pole region by Coulomb force in the diameter direction generated by a quadrupole high-frequency field.

16. The Q-pole type mass spectrometer of claim 15, wherein the control of the motion in the axial direction of the ions to be measured within said Q-pole region comprises deceleration of the ions followed by acceleration of the ions so that the ions have a speed that is higher while staying within a speed range in which mass separation is achieved.

17. The Q-pole type mass spectrometer of claim 15, wherein the control of the motion in the axial direction of the ions to be measured within said Q-pole region comprises maintaining ions sojourning within said Q-pole region and intermittently sending sojourning ions toward said collector.

B,
Cont
18. The Q-pole type mass spectrometer of claim 15, wherein the control of the motion in the axial direction of the ions to be measured within said Q-pole region comprises decelerating the ions within the Q-pole region to a speed range in which mass separation is achieved after the ions to be measured pass an entrance fringing region at a speed that is sufficiently high to avoid fringing problem influences.

19. The Q-pole type mass spectrometer of claim 15, wherein the control of the motion in the axial direction of the ions to be measured within said Q-pole region comprises, after the ions to be measured pass an entrance fringing region at a speed that is sufficiently high to avoid fringing problem influences, maintaining the ions sojourning within the Q-pole region and intermittently sending sojourning ions toward said collector.

20. The Q-pole type mass spectrometer of any one of claims 16-19, wherein the control of the motion in the axial direction of the ions to be measured within said Q-pole region comprises using Coulomb force generated by an electric field formed by four Q-poles of said Q-

pole type mass spectrometer, wherein said four Q-poles have equal DC potentials except for a DC potential U at the same position in the axial direction of each Q-pole of the four Q-poles, while each Q-pole of the four Q-poles has a different DC potential depending on the position in the axial direction.

21. The Q-pole type mass spectrometer of claim 20, wherein the four Q-poles have a thin film formed thereon on at least part of the surfaces thereof such that the DC potential differs depending on the position of each Q-pole in the axial direction, and a high-frequency voltage V and DC voltage U are applied to the thin film.

22. The Q-pole type mass spectrometer of any one of claims 16-19, wherein the control of the motion in the axial direction of the ions to be measured within said Q-pole region comprises using a reaction force generated by collision between the ions to be measured and the reduced pressure gas.

23. The Q-pole type mass spectrometer of claim 22, wherein the control of the motion in the axial direction of the ions to be measured within said Q-pole region comprising using a reaction force generated by collision between the ions to be measured and the reduced pressure gas is carried out by feeding the gas from said ion source toward said collector.

24. The Q-pole type mass spectrometer of any one of claims 16-19, wherein the control of the motion in the axial direction of the ions to be measured within said Q-pole region comprises setting the length of said Q-pole, the kind of gas and the pressure of the gas, the potential of said ion source and the potential on an axis of said Q-pole, whereby the ions to be measured are capable of passing through the Q-pole region without receiving any additional force in the axial direction.

25. The Q-pole type mass spectrometer of any one of claims 16-19, wherein the control of the motion in the axial direction of the ions to be measured within said Q-pole region comprises using a Coulomb force generated by a space charge formed by the ions to be measured with the Q-pole region.

26. The Q-pole type mass spectrometer of claim 25, wherein the potential on an axis of said Q-pole region is lower than a potential on the axis in an entrance fringing region and higher than a potential on the axis in an exit fringing region.

27. The Q-pole type mass spectrometer of any one of claims 16-19, wherein the control of the motion in the axial direction of the ions to be measured within said Q-pole region comprises using Lorentz force generated by a high-frequency magnetic field synchronous with a quadrupole high-frequency electric field that is applied in the diameter direction.

B)
Sons
28. The Q-pole type mass spectrometer of any one of claims 16-19, wherein the control of the motion in the axial direction of the ions to be measured within said Q-pole region comprises using electromagnetic induction force generated by a magnetic field that changes in intensity over time and is applied in the diameter direction.

29. The Q-pole type mass spectrometer of claim 15, wherein the control of the motion in the axial direction of the ions to be measured within said Q-pole region comprises deceleration of the ions due to collision followed by acceleration of the ions so that the ions have a speed that is higher while staying within a speed range in which mass separation is achieved.

30. The Q-pole type mass spectrometer of claim 15, wherein the control of the motion in the axial direction of the ions to be measured within said Q-pole region comprises deceleration of the ions due to collision with the environmental gas followed by acceleration of the ions so that

the ions have a speed that is higher while staying within a speed range in which mass separation is achieved.

31. A Q-pole mass spectrometer, comprising:
four poles arranged to form a Q-pole region having an axis extending in an axial direction,
said four poles extending along the axis;
an ion source operable to emit ions to be measured into said Q-pole region; and
a collector positioned to receive ions from said Q-pole region;
wherein said four poles, said ion source and said collector are in a reduced pressure gas environment; and
wherein said four poles, said ion source and said collector, in said reduced pressure gas environment, incorporate means for controlling the motion in the axial direction of the ions to be measured, advancing from said ion source toward said collector in said Q-pole region, at the same time that the ions to be measured are subjected to mass separation in said Q-pole region by Coulomb force in the diameter direction generated by a quadrupole high-frequency field.

32. The Q-pole mass spectrometer of claim 31, wherein said means accelerates the ions to be measured within said Q-pole region to a speed within a range in which mass separation is achieved after the ions to be measured have been decelerated.

33. The Q-pole mass spectrometer of claim 31, wherein said means accelerates the ions to be measured within said Q-pole region to a speed within a range in which mass separation is achieved after the ions to be measured have been decelerated due to collision.

34. The Q-pole mass spectrometer of claim 31, wherein said means accelerates the ions to be measured within said Q-pole region to a speed within a range in which mass separation is achieved after the ions to be measured have been decelerated due to collision with the reduced pressure gas.

35. The Q-pole mass spectrometer of claim 31, wherein said means maintains the ions to be measured sojourning within said Q-pole region and intermittently sends sojourning ions toward said collector.

36. The Q-pole mass spectrometer of claim 31, wherein said means decelerates the ions within the Q-pole region to a speed range in which mass separation is achieved after the ions to be measured pass an entrance fringing region at a speed that is sufficiently high to avoid fringing problem influences.

37. The Q-pole mass spectrometer of claim 31, wherein said means, after the ions to be measured pass an entrance fringing region at a speed that is sufficiently high to avoid fringing problem influences, maintains the ions sojourning within the Q-pole region and intermittently sends sojourning ions toward said collector.

B,
Cano 38. The Q-pole mass spectrometer of one of claims 32 and 35-37, wherein said means uses Coulomb force generated by an electric field formed by four Q-poles of said Q-pole type mass spectrometer, wherein said four Q-poles have equal DC potentials except for a DC potential U at the same position in the axial direction of each Q-pole of the four Q-poles, while each Q-pole of the four Q-poles has a different DC potential depending on the position in the axial direction.

39. The Q-pole mass spectrometer of claim 38, wherein said four Q-poles have a thin film formed thereon on at least part of the surfaces thereof such that the DC potential differs depending on the position of each Q-pole in the axial direction, and a high-frequency voltage V and DC voltage U are applied to the thin film.

40. The Q-pole mass spectrometer of one of claims 32 and 35-37, wherein said means uses a reaction force generated by collision between the ions to be measured and the reduced pressure gas.

41. The Q-pole mass spectrometer of claim 40, wherein said means feeds the reduced pressure gas from said ion source toward said collector to generate the collision between the ions to be measured and the reduced pressure gas.

42. The Q-pole mass spectrometer of one of claims 32 and 35-37, wherein said means comprises a set length of said Q-pole, the kind and pressure of the reduced pressure gas, the potential of said ion source and the potential on an axis of said Q-pole such that the ions to be measured are capable of passing through the Q-pole region without receiving additional force in the axial direction.

43. The Q-pole mass spectrometer of one of claims 32 and 35-37, wherein said means uses a Coulomb force generated by a space charge formed by the ions to be measured with the Q-pole region.

44. The Q-pole mass spectrometer of claim 43, wherein the potential on an axis of said Q-pole region is lower than a potential on the axis in an entrance fringing region and higher than a potential on the axis in an exit fringing region.

B,
cond
45. The Q-pole mass spectrometer of one of claims 32 and 35-37, wherein said means uses Lorentz force generated by a high-frequency magnetic field synchronous with a quadrupole high-frequency electric field that is applied in the diameter direction.

46. The Q-pole mass spectrometer of one of claims 32 and 35-37, wherein said means uses electromagnetic induction force generated by a magnetic field that changes in intensity over time and is applied in the diameter direction.
